NON-PUBLIC?: N
ACCESSION #: 8812210111
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Brunswick Steam Electric Plant Unit 2 PAGE: 1 of 6

DOCKET NUMBER: 05000324

TITLE: Reactor Scram Due to Turbine Control Valve Fast Closure on High Level Turbine Trip Caused by Topaz Inverter Tripping and Loss of Power to Feedwater Control Logic
EVENT DATE: 11/16/88 LER #: 88-018-00 REPORT DATE: 12/15/88

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE TO NPRDS:

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

At 1026 hours on November 16, 1988, the Unit 2 reactor scrammed due to turbine control valve fast closure on a high level turbine trip. The unit was operating at 100% power. The Emergency Core Cooling Systems were operable and in standby readiness. During the event, Groups 1, 2, 3, 6, and 8 isolations were received. The D outboard main steam line isolation valve (MSIV) exhibited dual position indication. HPCI and RCIC received initiation signals and the RCIC system injected; however, the HPCI System received a trip signal and the injection valve immediately closed upon reaching full open. The operator manually opened the HPCI injection valve and restored level. Reactor pressure was controlled by auto and manual safety relief valve actuation. By 1052 hours the operator had reset the Group 1 and 3 isolations, and reestablished the condenser as a heat sink.

The high reactor level was due to a feedwater logic control Topaz inverter tripping on high input voltage. The MSIV dual indication was due to a limit switch problem. HPCI is believed to have tripped on low suction pressure (LSP).

The inverter has been recalibrated, the MSIV limit switch has been readjusted and the HPCI LSP trip has been disabled. This event had minimal safety,

END OF ABSTRACT

Event

Unit 2 reactor scrammed due to a "Topaz" inverter tripping and causing the loss of B feed flow input to the feedwater control circuitry. This loss resulted in the feed steam flow error network of the control circuitry sensing a mismatch and subsequently demanding an increase in feed flow. The increased feed flow raised reactor level to the turbine trip point and the reactor scrammed on turbine control valve fast closure.

Initial Conditions

Unit 2 was operating at 100% power. The Reactor Core Isolation Cooling System (RCIC) (EIIS/BN), Automatic Depressurization System (ADS) (EIIS/*), High Pressure Coolant Injection System (HPCI) (EIIS/BJ), the A and B Residual Heat Removal/Low Pressure Coolant Injection Systems (RHR/LPCI) (EIIS/BO), and the B Core Spray System (CS) (EIIS/BM) were operable and in standby readiness. The A Core Spray System was operable in modified standby lineup. Three procedures were in progress at the time of this event: OPM-BAT004, Equalizing 125 Vdc batteries; 2MST-IRM22R, IRM Channels E & G Calibration/Functional Test; and 2MST-ATWS21M, ATWS Reactor Water LL2 Trip Unit Channel Cal.

Event Description

At approximately 1026 hours on November 16, 1988, the Control Operator (CO) responded to a CONDENSATE TRANSFER PUMP HEADER PRESSURE LOW annunciation on panel XU-3. Within a few seconds the second CO responded to a CONDENSATE HEADER PRESSURE LOW and noted that the pressure appeared normal. The second CO turned to question the first CO about any possible testing involving the condensate pressure annunciation when the first CO announced the reactor scram at 1026 hours.

The scram resulted room the turbine stop valves closing due to the generation of a high reactor vessel water level turbine trip signal. During the scram recovery, a Group 1 isolation was received on greater than 40% steam flow with the mode switch not in run. It was noted by the CO that the D outboard (2-B21-FO28D) main steam line isolation valve (MSIV) had dual position indication longer than the others. The MSIV closure resulted in level dropping (void collapse) below both the low level one (LL #1) and two (LL #2) setpoints. Upon reaching LL #1, low level reactor trip signals were generated and valve groups 2 and 6 received isolation signals and subsequently closed. Group 8 was already isolated due to being at operating pressure. When LL #2 was reached, HPCI and RCIC received initiation signals, Group 3 isolated, the reactor recirc pumps tripped, alternate rod insertion (ARI) tripped on one.

*EIIS component identifier not available

division (the other division was in test), reactor ventilation isolated and the Standby Gas Trains (SBGT) initiated. These systems functioned as expected, except for HPCI, which tripped after the initiation signal, causing the HPCI injection valve (2-E41-F006) to close after it fully opened. The trip automatically reset and HPCI came back up to speed; however, because level had recovered above the LL2 setpoint, the F006 logic did not require it to open. The CO manually opened the F006 to recover level more quickly. The increased reactor pressure caused safety relief valve (SRV) A (2-B21-FO13A) to auto lift at approximately the same time th&L' the CO manually operated (per procedure' i the B SRV (2-B21-FO13B) thus controlling reactor pressure. Approximately 2.5 minutes later the F SRV (2-B21-FO13F) was manually operated (per procedure) to control pressure. The operator reset the Groups 1 and 3 isolations, reset the scram and then reestablished the condenser as a heat sink at 1052 hours.

During the event, an attempt to restart the recirc pumps was unsuccessful due to a greater than 145 degree fahrenheit differential temperature between the steam dome and the bottom vessel drain. In addition, a cooldown rate of greater than 100 degrees fahrenheit on the bottom head was experienced. The bottom head experienced a maximum cooldown rate of 130 degrees fahrenheit per hour for one hour following the event.

Event Cause

The root cause of the reactor scram was the drifting downward of the "high input voltage" trip setpoint for the "Topaz" inverter that supplies power to the B feed flow, steam flow, and level inputs of the feedwater/level control circuitry. The normal high voltage trip point for the Topaz inverter is 145 Vdc. A calibration check done on the inverter after the event revealed that the inverter overvoltage trip setpoint had drifted down to 137 Vdc. This lowered setpoint resulted in the tripping of the inverter when its input voltage was increased above 137 Vdc during preventive maintenance (OPM-BATOO4) on the 2B2, 125 Vdc battery, by placing, th.e battery's charger supply to equalize. This particular inverter was a factory refurbished model and had been installed on October 22, 1988, to replace a unit which had begun to overheat on October 21.

(Internal failure was determined to be the cause of overheating). History indicates that it is normal for the high voltage trip setpoint to drift down after initial
installation of a new unit, and over the twelve month calibration period, but generally the setpoint remains well above battery limits. After three to four weeks of being loaded, the inverter is considered to be "burnt in." After a subsequent calibration, no significant drifting is noted. The unit had been calibrated and loaded for 12 hours prior to its installation and no potential problems were indicated. The resulting loss of the feed and steam flow inputs caused the feedwater level control

circuitry to see a steam flow/feed flow mismatch. The feedwater level control circuitry caused the reactor feed pumps to speed up and increase feed injection to the reactor. When level reached the high level trip point (approximately 208 inches) the main turbine and feed pumps tripped, generating the reactor scram.

The tripping of the Topaz inverter caused a loss of the B steam flow and feed flow inputs to the steam flow/feed flow error network. (The B level output was lost but did not affect the unit due to level being selected to a an A input).
I-his loss resulted in the three-element, level control circuitry sensing a higher steam flow than feed flow and an increase in reactor feed flow was demanded. (Note: B steam flow equals 25% of the total steam flow output whereas B feed flow equals 50% of the total feed flow output and the circuitry thus sensed 25% higher steam than feed flow.) The increased feed flow caused pressure to drop on the condensate header giving annunciation in the Control Room and auto starting the standby condensate pump. A rapid rise in reactor level ensued. The feedwater reactor level hi/low annunciator should have alerted the CO but the lamps were burned out. The annunciators had been verified operable earlier that morning prior to scheduled testing. The feedwater level transient was recognized at about the time of the high level turbine trip and resulting scram.

While responding to the scram the operator utilized the total steam flow recorder (2-C32-FR-R607) as the means of determining that steam flow was below 40%. However, the failure of the B steam flow input caused the indicated total to read low. A Group 1 isolation on greater than 40% steam flow with the mode switch not in run was incurred as the mode switch passed through startup when the CO was placing it to the shutdown position.

During the isolation, the D outboard MSIV showed dual position indication for approximately five minutes longer than the others. This indicated long closure time was determined to be a limit switch problem. After the event, stem travel was locally verified aid timed while the CO fast closed the MSIV. Stroke time and stem travel were within the expected limits and dual indication was not repeated. Computer traces indicate that, the HPCI System incurred an apparent trip while the F006 valve was opening, causing it to reclose. The system then automatically restarted, but the level was above the LL2 setpoint and the F006 was not required to reopen. It is believed that HPCI tripped on a momentary low pump suction pressure during the initiation. Posttrip data is not available to confirm the actual trip signal.

The large vessel differential temperature and the excessive cooldown rate of the bottom head resulted because the bottom head drain is plugged and the cold water injected by the control rod drive cooling system is not circulated when the recirc pumps are not running.

Corrective Actions

The inverter was removed, calibrated, and reinstalled. The plant will remain in single element with Level A selected for two weeks so that another failure will not affect plant operation. After the two weeks, another calibration will be performed. If the setpoint has stabilized, the plant will be placed in three-element control. The plant will remain in three-element without allowing the batteries to be taken to equalize for two additional weeks to ensure the inverter setpoint has stabilized. During this time period a spare inverter will remain powered up, with its setpoint also being monitored as a ready replacement. In the future, spare units will be powered up to provide burn-in time on the component prior to installation. This should minimize the amount of inverter setpoint drift after installation. During the startup of the unit, testing was conducted on the HPCI System using the 165 psig and 1000 psig flow test. This testing was conducted with special instruments installed to monitor both suction and exhaust pressure. This testing identified the fact that suction pressure pulsations can be recorded and could approach the setpoint for the low suction pressure (LSP) trip under certain conditions. As a result, a plant modification has disabled the LSP trip for Unit 2 and similar actions are underway for Unit 1 (currently in a refueling outage). In addition, a latching/seal-in function will be added to the LSP input relay to ensure that the annunciator is not inadvertently reset on a spurious low suction condition. When ERFIS monitoring of the point can be provided, plans are to remove the seal-in function. (Actions are underway at this time to provide the necessary ERFIS points for both Unit 1 and 2). The pump will continue to be protected by operator action prompted by the HPCI pump suction pressure Lo annunciator. This modification should increase its reliability.

In addition to the removal of the LSP trip, plans have been initiated to perform a HPCI injection test and to modify its hydraulic piping on both units. The injection test will be run prior to the changes on the hydraulic piping (the test is presently scheduled for December 16, 1988) to simulate conditions as close as possible to the time prior to the HPCI initiation during the Unit 2 scram. The test should confirm that the LSP trip was in fact the cause of the injection valve going closed. The modification to the hydraulic piping has been endorsed by GE as a means of preventing the transients experienced in turbine exhaust pressure and turbine speed during HPCI initiation by throttling the governor valve much more quickly than the present hydraulic system has been able to do.

The MSIV limit switch was adjusted to provide full closed indication with the valve in the closed position. The valve was stroked to ensure proper operation and verified closed locally. In addition, the valve will be fast closed on a monthly basis for two months to verify proper position indication along with stroke time as conditions permit following startup. The bottom head drain is scheduled to be unplugged during the upcoming refueling outage to allow for starting of recirc pumps following trips and prevent excessive cooldown rates on the bottom head.

Other methods of determining that steam flow is low enough to allow moving of the mode switch to shutdown without receiving a Group 1 isolation will be evaluated. Annunciator and abnormal operating procedures along with training on feedwater/condensate anomalies will be evaluated to see if they need improvement.

Event Assessment

This event had minimal safety significance as the unit is analyzed for a feedwater controller failure giving maximum flow demand and for a closure of all MSIVs from full power. In this instance, a power supply to an input for the controller failed, not the controller, and the group one isolation occurred after the scram initiation. Therefore, the feed pumps did not receive the instantaneous maximum demand signal which is analyzed as the most severe case of cold water injection, and the pressure spike resulting from the Group 1 isolation was mitigated by the fact that the control rods had already inserted on the turbine control valve fast closure scram signal.

The delay of the HPCI system's injection was of little safety significance as evidenced by the ability of RCIC to recover level above their auto initiation setpoint. If RCIC had failed to operate, the estimated ten second delay of the HPCI injection would still have been in time to prevent core uncovery. In the event of HPCI failure coincident with a small line break, the ADS safety relief valves were available to reduce reactor pressure and allow for the operation of the low pressure systems. The other systems, isolations, and trips operated as designed. An analysis of the overcooling event by the Nuclear Engineering

Department determined that the cooldown curve following a shutdown is conservative and the event did not enter the embrittling region.

ATTACHMENT 1 TO ANO 8812210111 PAGE 1 OF 1

CP&L
Carolina Power & Light Company

Brunswick Steam Electric Plant
P. O. Box 10429
Southport, NC 28461-0429
December 15, 1988

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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT UNIT 2
DOCKET NO. 50-324
LICENSE NO. DPR-62
LICENSEE EVENT REPORT 2-88-018

Gentlemen:

In accordance with Title 10 to the Code of Federal Regulations, the enclosed Licensee Event Report is submitted. This report fulfills the requirement for a written report within thirty (30) days of a reportable occurrence and is in accordance with the format set forth in NUREG-1022, September 1983.

Very truly yours,

J.L. Harness, General Manager
Brunswick Steam Electric Plant

TMJ/mcg

Enclosure

cc: Mr. B. C. Buckley
Mr. M. L. Ernst
BSEP NRC Resident Office

*** END OF DOCUMENT ***